SECTION 205

FEASIBILITY STUDY

SALT CREEK, LINCOLN, NE

PLAN FORMULATION PHASE

EVALUATION OF STRUCTURAL ALTERNATIVES

DOCUMENTATION

US Army Corps of Engineers
Omaha District
JULY 1996

damages, a review was made of the Salt Creek Floodway definition. The review of the definition indicated that the low spots could not be filled unless detention storage was also constructed to offset the rise in the water surface. The Salt Creek Floodway is defined as the middle of the levees with percentages of the area behind the levees left for flood storage. This definition was developed to confine the floodway between the existing levees. Based on this definition, filling in the levee low spots would be a violation of the current FEMA floodway regulations, which require a "no-rise" determination for fill in a floodway. Filling the levee low spots would require a revision of the floodway and possible compensation to each land owner in the affected cells or development of detention storage to offset the impacts. The floodway issues were discussed with the NRD in March 1995. Based on the discussion, a more detailed analysis of filling the levee low spots and a detailed cost benefit analysis was not warranted until after completion of the detention storage analysis.

PRELIMINARY DETENTION STORAGE ANALYSIS

The purpose of the detention storage analysis was to determine:

1) the location of potential detention storage sites on the tributaries to Salt Creek (Oak Creek, Middle Creek and upper Salt Creek above Haines Branch) existed,

2)estimate the area of storage available,

3) use the UNET model to evaluate the storage effects.

UNET Analysis

The procedures followed in the UNET analysis of potential detention storage sites were:

a. Identify potential detention sites on USGS quad maps on Oak Creek, Middle Creek, and Salt Creek upstream of Haines Branch.

b. Determine maximum storage capacity of each detention site and total the volumes by reach.

c. Modify the UNET Model by

1) Decapitating the previously-defined 50-, 100-, and 500-year SWMM hydrographs and subtract out the storage volume.

2) route the decapitated hydrographs separately and collectively through the system to determine effects on storage cells, tabulate the stages in each cell for all conditions along with existing model conditions.

3) From results of the analysis, choose two viable individual sites on which to perform a more detailed analysis.

Potential Detention Sites

USGS 7.S-minute quadrangle maps with 10-foot contours were used to identify three potential detention sites on Oak Creek, four on Middle Creek, and four on Salt Creek upstream of Haines Branch. Figure 1 shows the location of the storage sites. Sites were chosen based on available channel and off-channel storage, absence of structures or facilities, and the presence of natural or manmade boundaries such as roads and railroad tracks. The invert of each detention site was assumed to be essentially flat and the natural elevation of the overbank at the outlet was the detention site invert elevation. It was assumed that soil could be removed to the invert elevation across the entire site, creating a relatively uniform storage depth of ten feet or less.

Maximum storage Capacity

Each of the sites assumed at least 1V on 5H side slopes and tied into existing ground where possible. The conic method was used to determine potential storage capacity.

Modified SWMM Hydrographs

Previously-defined and calibrated 50-, 100-, and 500-year SWMM hydrographs for each of the three reaches were plotted using HEC DSPLAY and digitized to determine volumes. (The 10-year hydrographs were not analyzed

because the existing conditions analysis did not result in overflows to the storage cells.) The hydrographs were then decapitated by the collective storage volume in each reach using HEC DSSUTL, and replotted.

Routing the Hydrographs

The decapitated hydrographs stored in the DSS files were defined in the UNET boundary conditions input file. Using the existing "Top-of-levee" UNET model, the decapitated hydrographs were routed individually and collectively through the system to determine effects on water surface elevations in the storage cells. An output DSS file was created by the UNET model, from which DSSMATH was used to extract the maximum water surface elevation in each of the storage cells.

Results of Analysis

Existing and with-project results were compared by evaluating water surface elevation changes on storage cells on Salt Creek. Maximum water surface elevations resulting from routing the decapitated hydrographs, along with the existing model conditions indicated that sites OC1 and MC2 were viable independent detention storage areas on which to perform routing analysis. Site OC1 occupies mainly marshlands and has potential for 1140 acre-feet of storage. Site MC2 is primarily agriculture land and has potentially 1910 acre-feet of storage. A field review indicated that the OC2 storage area could be substituted for OC1 and would have less impact to the adjacent airport. Therefore, additional modeling was conducted using only MC2 and OC2 which represented a more reasonable storage volume and showed the highest potential for actual construction. The sites on upper Salt creek were determined to be infeasible due to the lower benefits and the environmental concerns of the areas.

Preliminary Economic Analysis

A Preliminary Economic Analysis was completed by computing the estimated annual damages (EAD) for the with-project conditions and subtracting them the existing condition EAD.

	EAD With-project	EAD Existing	Benefit
Oak Creek	$222,500	$277,800	$ 55,300
Middle Creek	$183,000	$277,800	$ 94,800

The results indicated that the benefits of providing approximately 1,100 acre feet of storage on Oak Creek would justify a $706,900 structure. The benefits of approximately 2,000 acre feet of storage on Middle Creek would justify a $1.2 million detention storage structure. Detailed analysis of these alternatives appeared justified.

DETAILED DETENTION STORAGE ANALYSIS

The analysis of the detention storage sites was conducted in more detail with the use of new survey data and 2-foot contour mapping. The level of detail was sufficient for a feasibility plan formulation analysis but not to a level of detail for final design. The majority of this analysis was conducted by the City of Lincoln and the Lower Platte South NRD as in-kind services.

Oak Creek Detention Storage

The detention pond OC2 on Oak Creek is located just west of the Lincoln Municipal Airport on the southwest corner of a bend in Oak Creek. It is located principally in the west half of Section 17, Range 6 East, Township 10 North.

The hydrology at the mouth of Oak Creek was obtained from the hydrographs for the 50-, 100-, and the 500-year design storms, with peak flows, respectively, of 13,500 cfs, 17,020 cfs and 22,780 cfs. The design of the detention pond should allow a maximum of approximately 12,500 cfs to pass by the proposed Oak Creek structure. The proposed detention structure would store flows above this value. The capture of all flows above 12,500 cfs would require a 1,200 acre-feet detention storage site.

It appears, from interpolating the flood profiles in the 1988 Flood Insurance study for Lincoln, Nebraska, that a flow of 12,500 cfs in the up-gradient region of the proposed detention structure would overtop the right bank at an elevation of approximately 1160 msl. Based upon the existing topography of the area this roughly matches the existing right bank in that region. A minor amount of cutting would be required in the upper end of the proposed site to obtain an elevation of 1160 msl. The right bank would act as a side-overflow weir as flows in Oak Creek exceed the right bank elevation and overflow into the detention structure.

The left bank adjacent to the airport appears to be a couple of feet higher than the right bank. During high flow events the left bank will protect the airport, while the right bank allows for high flood water to flow into the proposed detention pond.
The proposed location of the Oak Creek detention storage is an existing low area. The present average low elevation is at 1156 msl which is 4 feet below the right bank. The area would be excavated to 1151 msl or 9 feet below the right bank. Excavation would range from zero to 8 feet, with an average excavation of 4 1/2 feet. The excavation would be limited on the east by the channel and on the north by the radar site and an old hazardous waste site. On the south and west the excavation would end before reaching into the relative steeper side hills that begin approximately at the 1160 msl contour level. The side slopes are at 15:1 to allow for continued farming on the south and east sides of the site. The interior slope of the proposed detention site would be 0.003 ft/ft.

The primary outflow would be at the southern end of the proposed detention site. The outflow structure inlet invert elevation was estimated to be at 1146 msl and the outlet invert elevation at 1142 msl. This outlet elevation would be 3-4 feet above the normal flow of Oak Creek, and is estimated to be at an elevation of approximately 1138 msl. A water surface a above an elevation of 1160 msl, would cause the captured water to flow over the banks back into the creek, dependent upon the stage in Oak Creek. Additional outlet structure features would be developed in the final design phase. The detention pond would need to be high enough above the groundwater so as not to develop in to a wetland area. A wetland area in this vicinity is not desirable because of it's proximity to the Lincoln Municipal Airport.

The hydrologic calculations were performed using spreadsheet analysis. Results of the analysis indicate that for the 100-year design storm, the detention pond would store 1,188 ac-ft at an elevation of 1159.5 msl. The downstream peak would be 12,650 cfs and the pond would drain in approximately 2 1/2 days from the inception of the design storm.

Water would begin to flow into the detention site at 12,500 cfs. The 50-year design storm peak discharge of 13,500 cfs would barely overtop the inflow structure (right bank). The pond would store 108 ac-ft at an elevation of 1151 msl. The downstream peak would be 12,500 cfs, with a drainage time

for the detention pond of approximately 1 ½ days.

ACCESS

The existing levee road along the west edge of Oak Creek would be used for access to the site.

UTILITY CONFLICTS

Depending upon future development of the general area and on needs of National Guard facilities no existing or future utilities would be impacted by the detention storage.

SUMMARY

This area appears to be an adequate site for a detention pond. There is enough volume (1,237 acre-feet) to cut the peak of the 100-year flow to the desired level and conflicts are low except for the LES transmission Line. Wetland conditions would be undesirable at this location due to the adjacent municipal airport. The detention storage area would have to be designed so that it did not become a wetland.

Middle Creek Detention storage

The detention pond on Middle Creek is located just south of Middle Creek between SW 40th and SW 27th streets. It is located principally in the south half of section 29, Range 6 East, Township 10 North.
Hydrographs for the 50-, 100-, and the 500-year design storms, with respective peak flows of 9,000 cfs, 11,940 cfs and 16,300 cfs were used for Middle Creek. The design of the detention pond should allow a maximum of approximately 7,300 cfs to pass by the proposed Middle Creek structure. The proposed detention structure would store flows above this level. To capture of all flows above 7,300 cfs would require a 1,910 acre-feet detention storage site.

It appears from interpolating the flood profiles in the 1988 Flood Insurance Study for Lincoln, Nebraska that a flow of 7,300 cfs in the upper gradient region of the proposed detention structure would overtop the right

bank at an elevation of approximately 1158 msl. This would require excavation along the right bank in the upper portions of the proposed detention site. Compacted fill would be required to bring the lower portions of the right bank, up to a level of 1160 msl and provide additional capacity to the detention pond. The length or approximately 1,800 feet for the side-overflow weir was approximated assuming a falling water surface.

The elevation of the existing area ranges in elevation from 1156 to 1170 msl. The average excavation would be approximately 13 feet with the maximum excavations being around 19 feet in depth. The excavation would be limited on the north by the creek and on the west by SW 40th street. The south and east the excavation would terminate prior to reaching into the 1170 msl. contour elevation.

The side slopes would be constructed to l5H:1V along the south and east edges to provide for continued farming of these side slope areas. Along the west road and along portions of the bank not within the side-overflow weir the side slopes would be constructed to 5H:1V. The portions of the bank within the side-overflow area are set at a 10H:1V slope. The general slope of the proposed detention site would be 0.002 ft/ft.

Conceptually there are three primary outflows proposed for this detention structure. These allow for the ground to slope up to the south for a maximum distance of 2,000 feet. This allows for a greater detention area then would be allowed with just one outlet at the east end. All of the outflow structures would be single smooth bore 48" CMP's with flapgates.

Groundwater elevations significantly above the proposed ground eleva.tions would affect the capacity of the detention site. Groundwater at an elevation of 1149 msl would fill approximately 13 percent of the capacity of the proposed detention pond.

It would be desirable for this site to be used as a source of fill for the proposed Hobson Yard expansion to keep the fill in the floodplain to a net gain of zero. This area might also provide a wetland mitigation area. This would require further investigation.

The hydrologic calculations were performed using spreadsheet analysis. Results of the analysis indicate that for the 100-year design storm, the

detention pond would have a maximum storage of 1,749 ac-ft at an elevation of 1160 msl. This is less than the desired storage of 1,910 ac-ft. The reduced storage would cause a peak flow of 9,600 cfs downstream of the detention pond, which is significantly above the 7,300 cfs target level. It was estimated that the high flow above the target level would occur for about an hour. The pond would take approximately 3 days to drain from the inception of the design storm.

ACCESS

Access to the site would be from a proposed levee road. One would access the road on the southeast side of the bridge over Middle Creek on SW 40th Street. The proposed levee road will be a graveled surface 10' wide and 6" thick.

UTILITY CONFLICTS

Depending upon future development of the general area and on needs of the Hobson Yard facilities, no existing or future utilities would be impacted by the detention storage.

SUMMARY

This area appears to be a relative adequate site for a detention pond. The estimated volume is approximately 92 percent of the desired volume. It is physically possible to increase the volume, by increasing the side slopes. Potential conflicts in the area appear to be low and this might be a suitable site for wetland mitigation.

UNET Modeling of the Detailed Detention storage Areas

As described previously the hydrographs were routed through the design ponds using spreadsheet analyses. The spreadsheet routed the 50-, 100-, and the 500-year hydrographs through site OC2 on Oak Creek and site MC2 on Middle Creek. The resulting "with project" downstream hydrographs were then routed down to Salt Creek using the UNET model, to determine effects on storage cells along Salt Creek. Three UNET runs were completed to model the effects of both storage sites independently and combined. The 10-year discharges on Oak Creek and Middle Creek did not exceed channel capacities and were not included in this 'analysis. Figure 2 shows the location of detention sites OC2 and MC2.

Maximum water surface elevations in the Salt Creek storage cells resulting from routing the Oak Creek and Middle Creek downstream hydrographs were compared with existing conditions. The results indicate a significant reduction in flood depths in many of the cells along the Salt Creek floodplain.

HEC-2 Detention storage Modeling

The initial overtopping frequency was computed using the existing condition HEC-2 "top-of-levee" model and modifying the discharges based on the results of the three "with-project" UNET models. For the purposes of this analysis, the slope of the water surface and corresponding initial overflow location within each cell was assumed to be identical to the existing condition "top-of-levee" analysis. The initial over topping frequencies were computed for the Oak Creek Detention Storage and Middle Creek detention storage independently and combined. The results are tabulated in Appendix C. Stage reductions computed for the 100-year event using both detention storage sites ranged from 0 to 1 foot throughout the study reach. The initial over topping frequencies increased from 10 to 20 years.

DETENTION STORAGE COST ESTIMATE

A preliminary M-CASES cost analysis was completed for the construction work only. Many of the actual M-CASES costs were combined in the following tables for the report. Detailed break downs of the costs are included in Appendix D. The other costs associated with real estate, engineering and design and construction management were rough approximates used to provide "ball-park" estimates only.

TABLE 3
COST ESTIMATE FOR
OAK CREEK DETENTION STORAGE SITE

Land and Damages	Quant Unit	Contract	Cont.	Total Cost
Total Lands and Damages		$100,000	25,000	125,000
Construction Work				
Clearing and Grubbing	400 acre	197,689	49,422	247,111
Excavation	700,000 cyd	2,399,318	587,833	2,987,201
Outlet structures	1 ea	86,450	30,257	116,707
Misc. structures		157,392	55,070	212,462
Seeding and Mulching	400 acr	298,215	74,554	372,769
Total Construction Work		3,139,013	797,186	3,936,199
Planning, Engineering and Design		$200,000	50,000	250,000
Construction Management		$55,000	11,000	66,000
Total Oak Creek Detention Storage Site		$3,494,013	873,186	4,367,199

TABLE 4
COST ESTIMATE FOR
MIDDLE CREEK DETENTION STORAGE SITE

Land and Damages	Quant Unit	Contract	Cont.	Total Cost
Total Lands and Damages		$100,000	25,000	125,000
Construction Work				
Clearing and Grubbing	300 acre	132,084	39,625	171,709
Excavation	2,600,000 cyd	9,298,986	2,350,619	1,649,604
Compacted Fill	20,000 cyd	18,288	6,401	24,688
Outlet Structures		78,005	27,302	105,306
Misc. Structures		74,321	26,458	102,052
Seeding and Mulching	300 acre	223,661	67,098	290,760
Total Construction Work		9,826,618	2,517,503	12,344,120
Planning, Engineering and Design		$200,000	50,000	250,000
Construction Management		$55,000	11,000	66,000
Total Middle Creek Detention Storage Site		$10,181,618	2.603,503	12,785,121

DETENTION STORAGE ECONOMIC ANALYSIS

The economic analysis of the detention storage was conducted based on the estimated annual damages (EAD) of the top of levee models. The existing conditions "top-of-levee" EAD was determined to be $277,800 as compared to $507,00 for structure and content damages shown in Table 10 of the Problem Identification Documentation. The economic analysis shown in the Problem Identification Documentation was an EAD computed by using the "No Levee", "Probable Non-failure Point" (PNP), "probable Failure Point" (PFP), and "Top of Levee" models. Damages were significantly greater because the levee was assumed to fail before it was overtopped. The EAD computed for the top of

levee and the residual damages of each alternative evaluated are proportionally less. Therefore, the estimated benefits of the different alternatives should be close to that resulting from a more detailed analysis and are sufficient for the initial plan formulation.

Detention Storage Estimated Annual Damages

Three detention storage alternatives were evaluated: 1) Oak Creek, 2) Middle Creek, and 3) Combined Middle and Oak Creek. Both the with-project damage/frequency relationships for the storage alternatives and the withoutand with-project estimated annual damages (EAD) were computed for the three alternatives. The difference in these figures represent the corresponding benefits. A summary is shown below.

	EAD With-project	EAD Existing	Benefit
Oak Creek	$244,700	$277,800	$ 33,100
Middle Creek	$187,600	$277,800	$ 90,200
Combined	$175,400	$277,800	$102,400

The results of the analysis are slightly different from the preliminary results for two reasons. First, the initial over-topping frequency for the final analysis were computed by actually re-running the HEC-2 model instead of

using a linear interpolation of the existing conditions results. Therefore the initial over-topping frequencies varied by 5 to 10 years. Second, the final estimated annual damages were different because the actual detention sites reduction in discharge was smaller than those estimated in the preliminary analysis results

The benefit-cost analysis is shown below. An economic life of 50 years and 7.625 % interest was used for evaluation purposes. Operation and maintenance costs presented in the table are estimated, based on experience at similar sites.

TABLE 4
Detention storage
Benefit-cost Analysis

	Oak Creek	Middle Creek	Combined
First Cost	$4,367,199	12,785,121	17,152,320
Annual Cost			
I&A (50 years @ 7.625%)	341,667	1,000,243	1,341,910
Annual Benefits	33,100	90,200	102,400
Benefit/Cost Ratio	0.1	0.09	0.08

None of the alternatives would have positive net benefits. The detention storage alternatives have been determined not to be cost-effective solutions, and further study of these alternatives is not warranted.

CONCLUSION

Based on the plan formulation analysis completed for the levees along Salt Creek in Lincoln, Nebraska, there does not appear to be any feasible structural alternatives. The NRD and the Omaha District have consulted on these results and agree that no further section 205 studies will be completed on structural alternatives to reduce the flood hazards along Salt Creek in Lincoln, Nebraska. The Section 205 Feasibility Study efforts will concentrate on identifying those possible non-structural alternatives that may exist. A feasibility analysis of a flood warning system will be completed within the next six months.

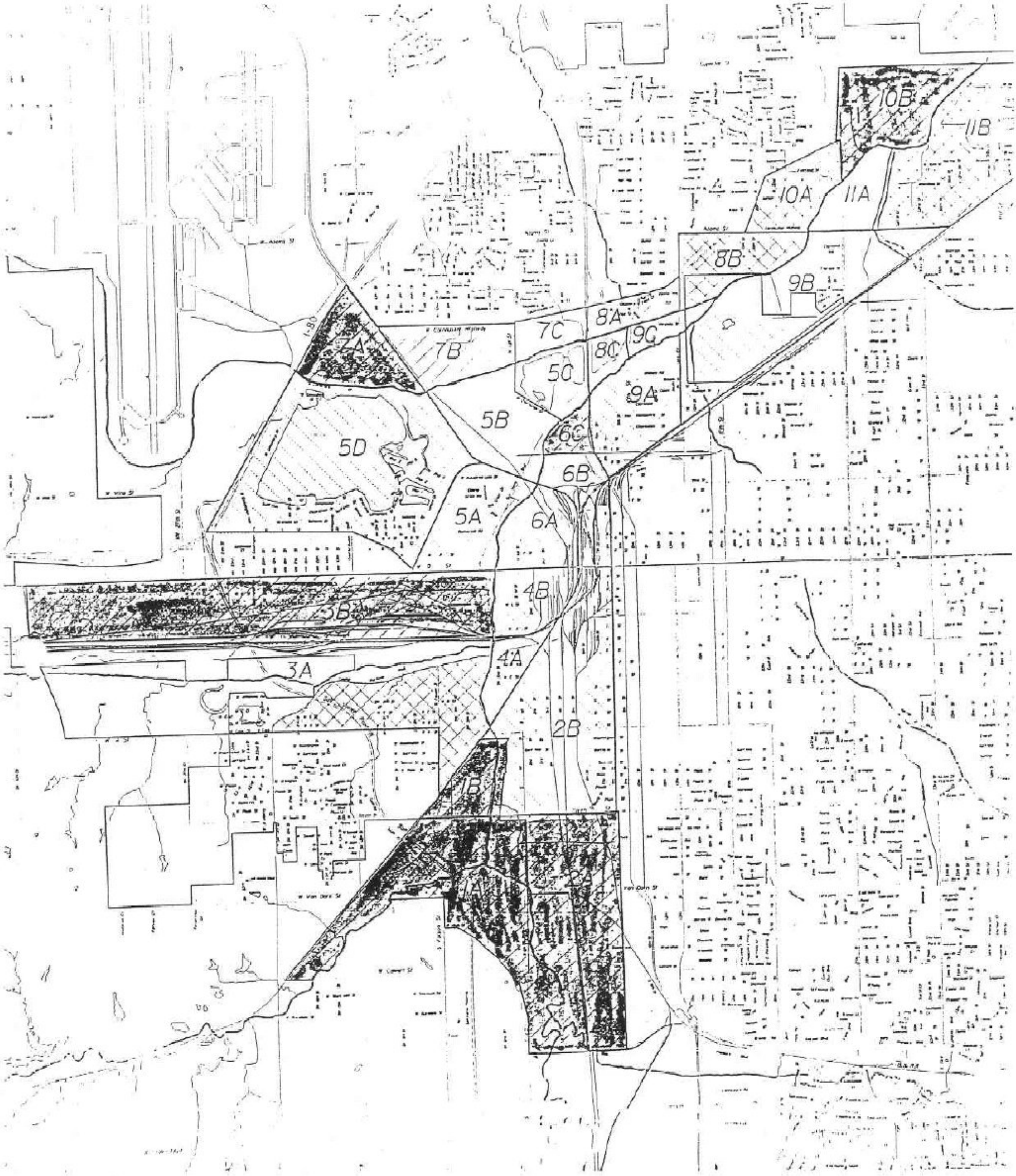

Figure 1 - Location Map UNET Cell Location

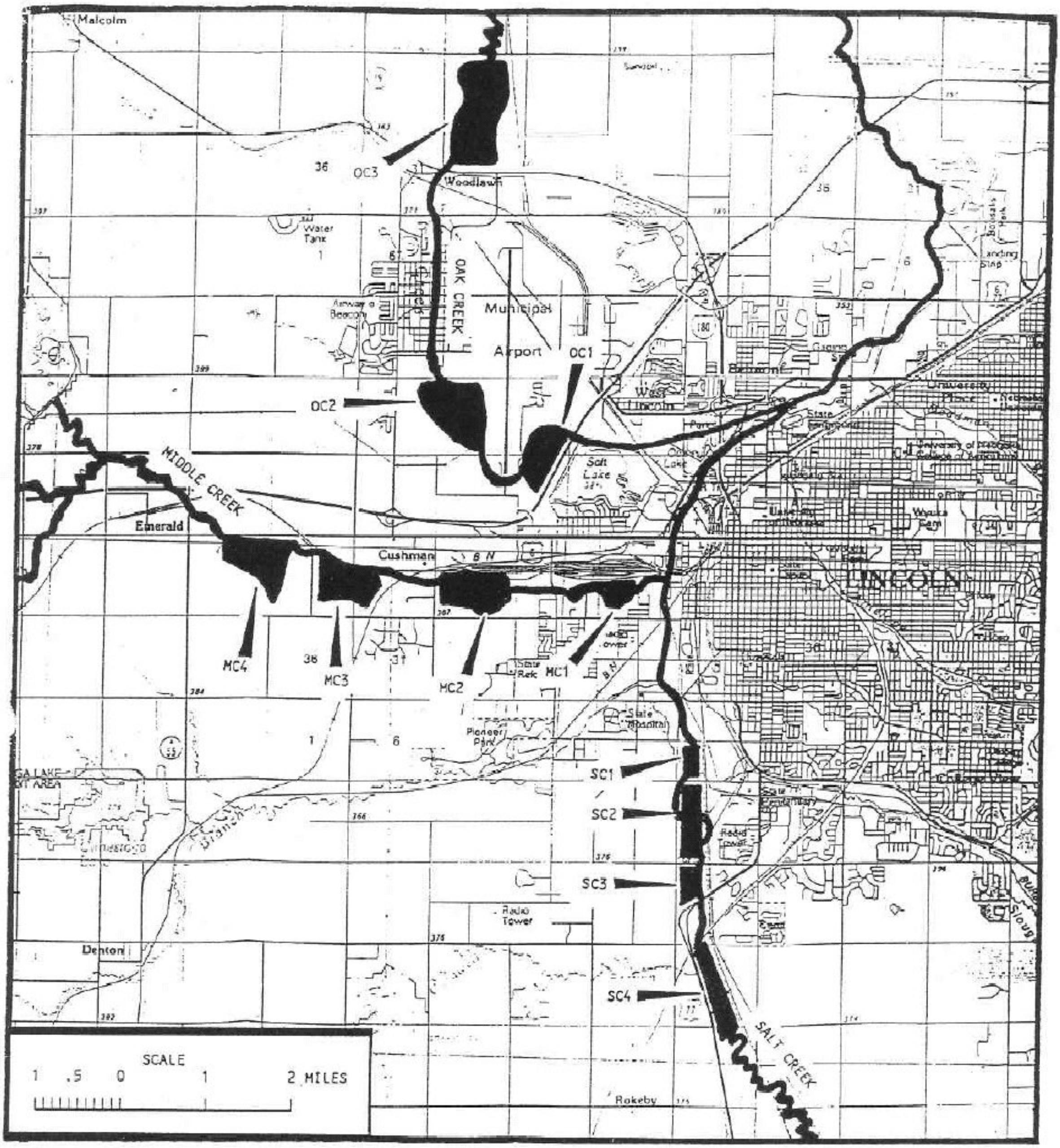

Figure . Location Map, Salt Creek Feasibility Study
Detention Storage Sites, Lincoln, Nebraska

Figure 2 - Detention Storage Location Map